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PROJECT FILE

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**RECONNAISSANCE SURVEY OF STREAMS IN THE
WHITE CAP FIRE MANAGEMENT AREA**

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Report to
U. S. Forest Service, Northern Forest Fire Lab,
Missoula, Montana, on Reconnaissance Survey
of Streams in the White Cap Fire Management Area

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Fire has perhaps a greater impact on more components of the forest ecosystem than any other single natural phenomenon. Since the aquatic environment is an integral part of this system it is important to examine its responses to fires. With the initiation of a comprehensive fire management study in the Selway-Bitterroot wilderness area a unique opportunity exists to examine the effects of unsuppressed natural fires on aquatic systems. Because the ramifications of this program are quite significant it is essential that the opportunity be taken to document the effect of fire on this important component of the forest ecosystem.

This report summarizes observations made during a reconnaissance survey of the White Cap Creek fire management study area during August, 1974 and presents possible research options and methodologies as we feel they relate to the fire ecology program. The report format will include discussions of both long and short-term effects of fire on streams, suggested sampling techniques and a possible monitoring scheme for the Fritz Creek fire as well as the White Cap drainage.

It must be stated at this point that any definitive study of the effects of fire on streams will require qualified personnel, time, complete logistic support and sufficient funding to bring the study to a satisfactory conclusion. Any recommendations we make regarding possible sampling schemes will be based on the premise that these criteria can be met. We are, however, aware of the limited funds available for this type of work on the project so will suggest minimum levels of effort required to obtain the type of information we feel most relevant to the present study and other areas considering fire management programs.

Immediate Effects of Fire

Immediate effects will be defined as those which occur during the fire. One immediate effect of fire could be an increase in stream temperature. This, of course, would depend on the size of the stream and the intensity of the fire. Any significant increase in temperature could trigger a catastrophic drift of stream insects (Waters, 1972). Sudden temperature increases have also been shown to stimulate insect emergence. With the burning of riparian vegetation, adult insects resting in the area would also be destroyed although at any one time these would probably represent only a small percentage of the total population present in the stream.

Addition of organic matter to the stream course from needle drop, forest litter and ash associated with fire could have a profound effect on the stream environment by altering water chemistry. Immediate or delayed needle drop from scorched trees could be of particular significance. Seawell (1967), in a study of the effects of yellow pine litter on small lakes found that leachates from tree litter reduced alkalinity, added color, increased oxygen demand and biogenic salt concentrations (phosphate and nitrate) as well as the organic load on the lake waters. Similar changes are likely to occur in a stream system in the event of an extensive needle drop in or even near a stream in a burn. These changes would be accentuated even more if post-fire weather conditions were such that large quantities of forest litter were flushed into the stream.

Changes in water chemistry brought about by the above mentioned factors inevitably result in alterations in algal, invertebrate or vertebrate community structures due to changes of the basic energy sources from which these communities derive their support.

Streams in the White Cap area do not appear, in themselves, to be highly productive. Water chemistry data alone would seem to support this observation. It is suspected that communities in most of these creeks are dependent on allochthonous energy sources (i.e., energy sources not from within the stream) for their existence. A fire which opens the forest canopy over a stream allowing greater amounts of sunlight to enter and which greatly reduces or eliminates available allochthonous energy sources thus could drastically change the basic functional nature of the stream community from one dominated by heterotrophic organisms to one dominated by autotrophic life forms. (This phenomenon has been observed following 100 percent clearcutting along small streams.) How long it would take for a stream to return to its pre-fire mode of existence or whether it could even do so is difficult to predict. We know of no investigations where this has been clearly documented.

The immediate physical effects of fire probably have only short-term consequences on lotic communities due to the normal mechanisms of recolonization, which, in the case of most major components of the community, include downstream drift (Waters, 1964). Some aquatic insects and other invertebrates have been noted to fly upstream upon emergence or otherwise move in an upstream direction (Minkley 1964) thereby recolonizing areas denuded of insects and other invertebrates by or as the result of the fire.

Any monitoring scheme established to detect the immediate or short-term effects of fire has the advantage of not requiring an extensive pre-fire baseline investigation although this would be desirable. Assuming the entire water course to its headwaters is not totally burned, the area immediately upstream from the fire can act as a control station for many measurements.

Temperature measurements can be made with submersible recording thermographs, which have the advantage of being completely submersed in the water and

thus would not be damaged as the fire moved along or over the stream.

Drift nets could be used for monitoring both invertebrate drift and any immediate increases in organic drift. Based on our observations of the Fritz Creek burn, a reasonable sampling scheme would include drift stations above, in and below the fire. A fairly intensive sampling effort would be recommended during the actual burn if at all possible. Just about any fire which burns along or across a stream could provide valuable information on immediate impacts on the aquatic system so sampling need not be restricted to the White Cap Creek drainage. Downstream stations which extended for a considerable distance below the fire could provide some insight into the extent and final deposition of organic drift.

There are certain limitations associated with invertebrate drift sampling which one should be aware of. Drift patterns in insects vary both seasonally and daily and should be evaluated accordingly. Across stream variability in drift has been well documented. It is also possible that drift may be greater near the stream banks due to greater fire intensity in this area. For statistical purposes measures of depth, velocity, specific location and possibly temperature should be recorded at each net.

The immediate effects of fire on the algal community of a stream are difficult to surmise. Effects probably would be delayed somewhat and changes that did occur would probably be related to subtle or perhaps not so subtle changes in water chemistry which would be more related to the long-term effects. Unless water temperatures increased significantly (say more than 10° C) during the fire it is unlikely that short-term low magnitude temperature increases would greatly affect the algal community. This would, of course, depend on the type of algae present and the time of year the fire occurred. Certain blue green algae can withstand very high temperature while green algae have fairly

narrow temperature limits. Certain algal floras characteristically develop during different seasons, i.e., the summer flora is probably quite different than the winter flora. In any respect, any "losses" which would occur as the result of increased temperature would probably be rapidly replaced after water temperature dropped to pre-fire levels.

Long-term Fire Effects

Long-term effects of fire are those which cause changes in the aquatic system during the post-fire period or until pre-fire norms in community structure return. The most significant changes in the aquatic system are probably associated with these long-term effects.

The Forest Service, as well as other federal and state agencies, have addressed sedimentation problems (resulting from fires as well as other causes) and methodology for studying their effects for some time. Platts (1968, 1970, 1972, 1974a, 1974b) very adequately describes recent work done by the Forest Service on the Salmon River drainage.

The extent of sedimentation resulting from a forest fire depends on many factors including soil type, slope, fire intensity, revegetation rate and post-fire climatic conditions. Sediments which enter a stream may have the direct effect of clogging the gills of invertebrates and young fishes. These suspended materials may also reduce the penetration of sunlight and thus suppress primary production in the stream (Hynes, 1960). Filling of bottom substrate interstices with fine sediments can reduce invertebrate habitat, fish spawning habitat (Phillips, 1970), and reduce the flow of oxygen-rich water (Ziebell, 1960). Bachman (1958) observed significant reduction in volume of invertebrates in Idaho streams following sedimentation from logging road construction.

The reports by Platts can be consulted for methodology regarding sedimentation measurement. A technique has recently been developed for obtaining in situ samples of substrate from rocky stream beds such as are found in White Cap Creek and its tributaries (Stocker and Williams, 1972). The technique uses liquid nitrogen to freeze the substrate around a standpipe driven into the stream bed. The standpipe is lifted from the bed with a representative core frozen intact around the pipe. Physical measurements which can then be obtained include particle size distribution, porosity, mean grain size and heterogeneity of grain size. Samples above, in and below the fire would seem appropriate in ascertaining the changes in sediment deposition related to the fire. The effects of scouring high water during spring runoff, as occurred in 1974, should be kept in perspective however, when making sedimentation measurements such as these.

Deposition of organic debris such as leaf litter, bark, needles, etc. on the stream bed may have an effect on the aquatic system similar to that of sedimentation. It may also have the effect of providing nutrients to the invertebrate community. A more direct effect may be in providing physical habitat for certain aquatic insect forms such as caddis fly larvae.

Loss of riparian vegetation could have a significant impact on the aquatic community, particularly in small streams. However, if riparian vegetation recovers as rapidly as it did along White Cap Creek following the Fritz and Snake Creek fires, its long-term impact would be greatly reduced.

Increased sunlight entering a stream following vegetation losses could increase water temperatures as well as photosynthesis. The change this brings about in the "functional" nature of the stream has already been discussed. Devegetation would also result in loss of cover for fish and resting places for adult insects. This latter event could result in a disruption of upstream

recolonization cycles (Pennak, personal communication).

Simple photographic techniques might be used to some advantage in documenting the reduction of riparian vegetation. Meteorological balloons have been successfully employed in Europe for elevating cameras to suitable heights for photographic vegetation in small streams. This technique should be well suited for recording pre and post-fire changes in riparian vegetation density in the narrow, heavily wooded canyons through which the streams in the area often flow.

Most of the effects of fire discussed thus far result in either a direct or indirect change in nutrient loading on the system. Routes of transfer and ultimate deposition of these nutrients are of particular interest in both the terrestrial and aquatic systems. Sampling of ground water in and around the burn can be facilitated by the use of tube tension lysimeters (Parizek and Lane 1970). Should this method be employed, input from a hydrologist might be useful in locating suitable sampling sites.

Because aquatic plants are able to accumulate certain nutrients in excess of their needs, they can often be used as indicators of the presence of nutrients which otherwise might be present in only small quantities or which were present in the environment for only a short period. Tissue analysis of algae or possibly mosses common to all study stations on a stream course could provide another insight into evaluating nutrient supplies in natural waters associated with fires. Extensive growth of *Hydrurus* and *Stigeoclonium*, which are common during late summer in the area, would be quite suitable for this type of analysis. Gerloff and Krombholz (1966) present a discussion and evaluation of tissue analysis techniques in aquatic systems.

Benthic macroinvertebrates are perhaps the best biological indicators of water quality in streams. Their habitat preferences and low motility prevent

extended rapid migrations from disruptive environmental conditions and cause them to be directly affected by foreign substances entering the aquatic environment. Because of this full-time monitoring capacity, macroinvertebrates will probably provide the most information about the extent and duration of changes in the aquatic system caused by forest fires.

A variety of methods are available for macroinvertebrates sampling. Due to the large-cobble bottom type observed in White Cap Creek and other waters in the area, it appears that artificial substrates would be the most satisfactory collecting device. Details on possible sampling schemes for long-term monitoring are included in the following section.

Suggested Fritz Creek Post-fire Monitoring Scheme

It is unfortunate that studies of the aquatic systems, including lakes, in the fire management area could not have been initiated earlier. Fortunately, because of the behavior of the Fritz Creek fire, it is possible to obtain considerable information about its effect on White Cap Creek by employing areas upstream of the burn as control stations. A monitoring scheme on White Cap Creek will provide information not only on long-term effects of the Fritz Creek fire but control station can be used to some extent for documenting pre-fire conditions above the Fritz Creek burn. The importance of documenting pre-fire conditions cannot be overstated.

Water Quality

Dave Alrich's proposed water analyses that we briefly examined while in Hamilton appeared satisfactory. Possibly the addition of a station on Paloma Creek and one just above Paloma on White Cap Creek would also be informative.

Ideally, monthly samples from above, in and below the burn would be desirable. If after a year little difference was noted between the stations, this schedule could be substantially reduced to perhaps four samples per year to monitor possible delayed effects.

Algae

EPA slide samplers or other similar sampling devices would be suggested for monitoring changes in algal communities. At least four samplers per station would be desirable. Species identification and relative abundance information could readily be obtained from these samples. If sufficient algae develop on the slides, the fairly simple straight forward ratio of organic matter to chlorophyll a (autotrophic index) could be calculated. This index reflects the relative organic load on the system. Sampling of this type would probably be feasible only during ice and snow free periods.

Further data analysis could include a variety of methods. Cluster analysis of presence-absence data might be satisfactory here.

Macroinvertebrates

Because of the cobble type bed in White Cap Creek, rock or bark filled basket samplers would probably be most suitable for collection of macroinvertebrates. Both of these substrate types have advantages and disadvantages which should be considered (see appendix B). Regardless of which type of substrate is used, the samplers should be elevated above the stream bottom to avoid as much as possible natural substrate induced variability. Approximately 30 days has proven to be sufficient to allow adequate colonization of the substrate material. Basket samplers should be removed from the stream with some care to avoid dislodging more motile forms which may be present. To reduce species

lists to a more manageable and meaningful form, several alternatives exist. These include the calculation of taxonomic-numeric diversity indices, biological indices, similarity indices or possibly the evaluation of qualitative (presence-absence) data using cluster analysis techniques.

Watershed Monitoring Scheme

The six water analysis stations presently established plus the two at Paloma Creek should provide a reasonably comprehensive sampling of water quality on the White Cap Creek drainage. An occasional sample from near the headwaters of White Cap Creek might be collected to compliment those taken from lower stations. The analyses proposed by Aldrich should be sufficient for general purposes. For general baseline information, samples should be collected on at least bimonthly intervals.

Algae and invertebrates could be sampled at these same water quality stations in a manner described in the previous section. An absolute minimum of three sampling periods per year is advised. At least four samplers per station are suggested with a minimum of two. Monitoring should continue for the duration of the fire management studies.

Other Watersheds

Streams in any accessible watershed in or near the fire management area can serve to provide some information on both long and short-term fire impact. We suggest at least a reconnaissance survey of nearby watersheds to document some of the attributes of their streams. A record of their suitability for attaining certain specified sampling goals as they directly relate to the overall aquatic studies should be recorded. In the event that a fire or fires

occur along these streams, some effort could then be concentrated in those areas in which some previous data were available.

Qualitative Algal Analyses of Samples From White Cap Creek Drainage

Methods

Seventeen representative algal samples from streams of the Selway-Bitterroot fire ecology project were preserved in FAA and transported in Whirl-Pac Bags. In the laboratory, thalli were separated into individual components using a Swift Stereo 80 dissecting scope. Remaining fluid from each sample was filtered to obtain a concentrate of diatoms and other microscopic specimens. Final identification of all material was made with a Leitz compound microscope at magnifications of 150x and 600x.

Findings are reported by individual sample. A species list is included.

Discussion

In general, the algal flora present in these samples is that of oligotrophic, cold-water mountain streams with low mineral content, the thalli attaching to rocks, moss, debris and/or larger algal plants. A minimum of planktonic species was observed.

Variations in flora composition did occur among the several streams sampled--in species collected, in abundance of a particular species present, or in collection sites.

The Cedar Creek sample indicated a difference which might be due to a springy collection site, characterized by a cottony mass of Ulothrix variabilis,

intermixed with an abundance of Melosira varians and the presence of Tetraspora, Cosmarium, Pinnularia, Surirella, Frustulia and Eunotia. A greater number of diatoms were observed, but the dominant diatom of the watershed, Hannaea, was absent. Synedra ulna var. ramesi was seen in this one sample. The only Blue Green observed was Nostoc parmelloides. Many protozoans, nematodes and rotifers occurred. Some difference in pH of this stream is also indicated by the general composition of the flora.

Paloma Creek showed a dominance of Hydrurus foetida and few diatom species.

White Cap Creek had both Hydrurus foetida and Stigeoclonium nelsonii, but a greater variety than any other streams of Zygmataceous algae--Mouetotia, Spirogyra and Zygnema all being present.

Cooper's Creek was the only stream from which a sample of Drapernaldia was taken. The collection site was a quiet, mossy pool area. Some Hydrurus was present, but Tabellaria flocculosa was the only diatom observed.

Lookout Creek showed variation with some Hydrurus, Stigeoclonium, Ulothrix, Zygnema, Oedogonium and Nostoc. The diatom Hannaea was present in most of these samples.

Of the several streams sampled, White Cap Creek was the only one showing a significant imbalance. Most samples from this stream had a dominance of Stigeoclonium. Habitat data on the particular species found, S. nelsonii (known only from Montana), are not well documented, but the genus as a whole is considered a reliable, cosmopolitan pollution indicator. The other alga dominant in these samples is Phormidium. Note should be taken of the sample labeled "1 mi above wild. boundary, heavy burn area." Massive thalli of the Phormidium dominated this sample. Other Blue Greens--Stigonema, Tolypothrix, Oscillatoria, were frequent in the White Cap Creek samples. Thalli of Lemanea

collected at the Wilderness boundary were so heavily overgrown with *Entophysalis* that key characteristics needed for species verification were unobtainable. The dominant diatom of this stream is the rheophilic *Hannaea*, but diatom variation and abundance are considerable.

Algal Sample Analysis

White Cap Creek Drainage 13-16 August

Identifications by V. Clair Norton, Emeritus Faculty Member, Dept. of Botany, Colorado State University.

Collection Locations

- 1 White Cap Creek at Wilderness boundary
 - a Sample 1
 - b Sample 2
- 2 White Cap Creek above Wapati Creek
- 3 White Cap Creek one mile above Wilderness boundary-heavy burn area
- 4 White Cap Creek upstream from Lookout Creek
- 5 White Cap Creek upstream from Cedar Creek
- 6 White Cap Creek above confluence of Canyon Creek
- 7 White Cap Creek below confluence of Canyon Creek
- 8 White Cap Creek at trail mile 10+
- 9 White Cap Creek at trail mile 12
- 10 Wapati Creek at trail
- 11 Lookout Creek at trail
- 12 Cedar Creek at trail
- 13 Paloma Creek at trail
- 14 Mouth of Coopers Creek
- 15 Trail Head water supply point 31

SPECIES LIST

	Collection Locations															
	1a	1b	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<u>Chlorophyta</u> - Green Algae																
Ankistrodesmus falcatus (Corda) Ralfs										x						
Closterium sp.		x			x											
Cosmarium sp.													x			
Drapernaldia plumosa (Vauch.) A.A.Ag.															x	
Mougeotia sp.							x		x							
Oedogonium sp.					x		x						x	x		
Spirogyra sp.		x	x	x		x		x	x							
Stigeoclonium nelsonii Prescott	x	x	x	x	x	x	x	x	x	x						x
Tetraspora lubrica (Roth) C.A.Ag.													x			
Ulothrix variabilis Kutz.	x	x											x			
zonata (Weber & Mohr) Kutz.	x		x		x		x	x								x
Zygnema sp.					x	x	x		x	x		x			x	
<u>Chrysophyta</u> - Yellow Green Algae																
Hydrurus foetidus (Vill.) Trev.			x		x		x	x	x	x		x		x	x	
<u>Bacillariophyta</u> - Diatoms																
Achnanthes sp.	x				x		x		x	x	x					
Cocconeis placentula Ehr.											x		x	x		
Cymbella spp.	x	x	x	x						x						x
Diatoma anceps (Ehr.) Kirchn.	x															
hiemale var. mesodon (Ehr.) Grun.	x			x	x	x				x		x	x	x		x
Epithemia turgida (Ehr.) Kutz.													x			
sp.		x		x							x					
Eunotia spp.		x											x			
Frustulia rhomboides (Ehr.) DeT.													x			
Gomphonema spp.	x			x	x		x		x	x	x		x			
Hannaea arcus (Ehr.) Patr.	x	x	x	x	x	x	x	x	x	x		x		x		x
Melosira granulata (Ehr.) Ralfs				x			x					x				
roseana Rabh.			x													
varians C.A.Ag.	x	x											x			
Navicula spp.													x			x
Neidium iridis (Ehr.) Cl.		x														
Nitzschia sp.													x			
Pinnularia sp.		x											x			

	1a	1b	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Surirella linearis var. constricta (Ehr.) Grun.													x			
Synedra amphicephala var. austriaca (Grun.) Hust.				x	x		x		x	x			x			x
ulna (Nitz.) Ehr.													x			
ulna var. ramesi (Herib.) Hust.													x			
sp.	x											x				
Tabellaria flocculosa (Roth) Kutz.	x			x	x		x			x					x	x
<u>Cyanophyta</u> - Blue Green Algae																
Calothrix sp.																x
Entophysalis lemaniae F. lemaniae (Ag.) Dr.&Daily					x				x							
lemaniae f. elongata (Wille) Dr.&Daily	x	x														
Nostoc parmeloides Kutz.											x		x			
Oscillatoria sp.		x			x					x						
Phormidium retzii (C.A.Ag.) Gom.	x	x		x	x	x	x									x
Stigonema mamillosum (Lyngb.) C.A.Ag.		x	x		x		x									
Tolypothrix distorta var. penicillata (Ag.) Lemm.	x			x					x		x					x
<u>Rhodophyta</u> - Red Algae																
Lemanea sp.	x	x														
Chantransia-stage of Lemanea (juvenile)	x															

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